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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/710,828	08/05/2004	Daniel C. Edelstein	FIS920040159	4827

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WHITHAM, CURTIS & CHRISTOFFERSON & COOK, P.C.  
11491 SUNSET HILLS ROAD  
SUITE 340  
RESTON, VA 20190

EXAMINER

PIZARRO CRESPO, MARCOS D

ART UNIT PAPER NUMBER

2814

DATE MAILED: 10/19/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	Application No. 10/710,828	Applicant(s) EDELSTEIN ET AL.	
	Examiner Marcos D. Pizarro-Crespo	Art Unit 2814	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

#### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 29 August 2006.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 1-10 is/are pending in the application.
- 4a) Of the above claim(s) 10 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-7 is/are rejected.
- 7) ☒ Claim(s) 8 and 9 is/are objected to.
- 8) ☒ Claim(s) 1-10 are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 08 May 2006 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

Application/Control Number: 10/710,828 (Non-Final Rejection)  
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Attorney's Docket Number: FIS920040159US1 (00750492AA)

Filing Date: 8/5/2004

Claimed Foreign Priority Date: none

Applicant(s): Edelstein et al.

Examiner: Marcos D. Pizarro-Crespo

### **DETAILED ACTION**

This Office action responds to the amendment filed on 8/29/2006.

#### ***Continued Examination Under 37 CFR 1.114***

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after the final rejection mailed on 6/29/2006. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 8/29/2006 has been entered.

#### ***Acknowledgment***

2. The amendment filed on 8/29/2006, responding to the Office action mailed on 6/29/2006, has been entered. The present Office action is made with all the suggested amendments being fully considered. Accordingly, pending in this Office action are claims 1-10.

#### ***Claim Rejections - 35 USC § 102***

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

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A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1-5 are rejected under 35 U.S.C. 102(e) as being anticipated by Li (US 6955986).

5. Regarding claim 1, Li shows (see, e.g., fig. 1) all aspects of the instant invention including an integrated circuit including:

- A first layer **104** having a metal or metal alloy **102** at a surface thereof
- A second layer **108** adjacent to said surface having a metal or metal alloy via therein
- An interlayer connection between the metal/alloy of the first layer and the metal/alloy via

wherein the connection comprises a stable alloy region that has graded mechanical characteristics, contains a predetermined quantity of alloying material, and is restricted to an interfacial region of the metal/alloy of the first layer and metal/alloy via by a barrier layer (see, e.g., col.5/ll.15-28).

6. Regarding claim 2, Li shows the metal/alloy of the first layer is a first metal and the metal/alloy of the second layer is a second metal (see, e.g., fig. 1).

7. Regarding claim 3, Li shows the metal/alloy comprises copper (see, e.g., col.4/ll.23).

8. Regarding claim 4, Li shows the barrier including a layer of tantalum, tungsten, or titanium or alloys or nitrides thereof (see, e.g., col.5/ll.13).

9. Regarding claim 5, Li shows the barrier comprising a layer of tantalum nitride and a layer of tantalum (see, e.g., col.5/ll.13).

***Claim Rejections - 35 USC § 103***

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

11. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

12. Claims 1-4, 6, and 7, are rejected under 35 U.S.C. 103(a) as being unpatentable over Besser (US 6633085) in view of Lopatin (US 6368961).

13. Regarding claim 1, Besser (see, e.g., fig. 7) shows most aspects of the instant invention including an integrated circuit including:

- A first layer **30** having metal or metal alloy at a surface thereof
- A second layer **34** adjacent to said surface and having a metal or metal alloy via **52** therein
- An interlayer connection between the metal or metal alloy of the first layer **30** and the via **52**

wherein the interlayer connection comprises a stable alloy region **50** restricted by a barrier layer **46** to an interfacial region between the metal or metal alloy of the first layer **30** and the via **52**. Besser, however, fails to show the stable alloy region **50** having graded mechanical characteristics. Lopatin (see, e.g., abstract/II.6-10), on the other hand, teaches that providing said graded mechanical characteristics to Besser's alloy region would simultaneously provide the alloy region with good adhesion to both the barrier layer **46** and the copper line **30**.

It would have been obvious at the time of the invention to one of ordinary skill in the art to provide Besser's alloy region with Lopatin's graded mechanical characteristics to provide the alloy region with simultaneous good adhesion properties to both the barrier and the copper line.

14. Regarding claim 2, Besser shows the metal or metal alloy of the first layer is a first metal **30** and the metal or metal alloy of the second layer is a second metal **52** (see, e.g., fig. 7).

15. Regarding claim 3, Besser shows the metal or metal alloy comprises copper (see, e.g., col.4/II.51).

16. Regarding claim 4, Besser shows the barrier includes a layer of tantalum nitride (see, e.g., col.5/ll.54).

17. Regarding claim 6, Besser shows the metal alloy of the interlayer connection at said interface includes tin (see, e.g., col.5/ll.17).

18. Regarding claim 7, Besser shows the barrier **46** is above the interlayer connection and the metal alloy of the interlayer connection **50** is confined to a region below the barrier **46** (see, e.g., fig. 7).

19. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Besser in view of Lopatin and Wang (US 6884329).

20. Regarding claim 5, Besser shows most aspects of the instant invention (see, e.g., paragraph 13 above). Besser also shows that the barrier may be tantalum or tantalum nitride (see, e.g., col.5/ll.54). He, however, fails to show the barrier including both a layer of tantalum and a layer of tantalum nitride. Wang (see, e.g., col.5/ll.46-50), however, teaches that using both, tantalum would act as an adhesion layer and tantalum nitride as a barrier layer.

It would have been obvious at the time of the invention to one of ordinary skill in the art to have Besser's barrier comprising a layer of tantalum and a layer of tantalum nitride, as suggested by Wang, to have a copper diffusion barrier layer functioning as both an adhesion and a barrier layer.



***Allowable Subject Matter***

21. Claims 8 and 9 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

***Response to Arguments***

22. The applicants argue:

Li fails to disclose that the multiple sub-layers have graded mechanical characteristics.

The examiner responds:

Li clearly shows the above features of the claimed invention. See, e.g., col.3/ll.41-48 and col.6/ll.26-30, where Li teaches that the multiple sub-layers have the highest concentration of a barrier material, e.g., tungsten, at the bottom surface of the layer and the lowest concentration of the barrier material at the top surface thereof. Accordingly, the multiple sub-layers have the highest impermeability at the bottom surface, which impermeability gradually decreases towards the top surface of the sub-layers.

23. The applicants argue:

Li fails to disclose that the barrier layer is stable against the diffusion of materials therein. Further, there is no indication seen in Li that the diffusion barrier is intended to prevent the diffusion of any material other than copper. Claim 1, on the other hand, recites that the diffusion layer confines the alloying materials to the interlayer connection.

The examiner responds:

The applicants disclose in their specification that the barrier layer may be selected from the group consisting of Ta, Ti, W, or alloys or nitrides thereof (see, e.g.,



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par.0026). Li also shows the diffusion barrier comprising Ta, Ti, W, or alloys or nitrides thereof (see, e.g., col.5/ll.3-14). Since the applicants and Li show the same materials, they must have the same barrier properties.

24. The applicants argue:

There is no indication in Lopatin that the relative proportions of copper and tin (or other alloying metals; magnesium and aluminum being disclosed) is varied between layers or that the resulting composite layer 224 has graded mechanical characteristics.

The examiner responds:

Lopatin shows the above features of the claimed invention. See, e.g., abstract/ll.6-10, where Lopatin teaches that providing said graded mechanical characteristics to Besser's alloy region would simultaneously provide the alloy region with good adhesion to both the barrier layer 46 and the copper line 30. That is, the high nitrogen content at the bottom of the layer favors adhesion of the alloy layer to the barrier layer, whereas the lack of nitrogen at the top surface of the layer favor adhesion to the copper layer. See, e.g., Lopatin: col.3/ll.1-9.

### ***Conclusion***

25. Papers related to this application may be submitted directly to Art Unit 2814 by facsimile transmission. Papers should be faxed to Art Unit 2814 via the Art Unit 2814 Fax Center. The faxing of such papers must conform to the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2814 Fax Center number is **(571) 273-8300**. The Art Unit 2814 Fax Center is to be used only for papers related to Art Unit 2814 applications.

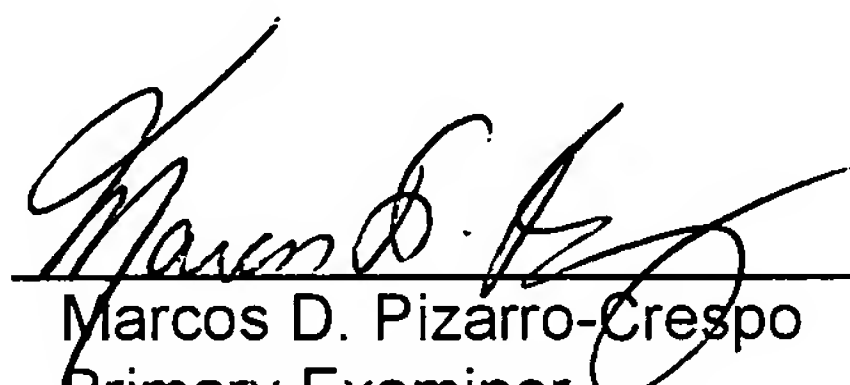
26. Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Marcos D. Pizarro-Crespo** at **(571) 272-1716** and between the hours of 9:30 AM to 8:00 PM (Eastern Standard Time) Monday through Thursday or by e-mail via [Marcos.Pizarro@uspto.gov](mailto:Marcos.Pizarro@uspto.gov). If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy, can be reached on (571) 272-1705.

27. Any inquiry of a general nature or relating to the status of this application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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28. The following list is the Examiner's field of search for the present Office Action:

Field of Search	Date
U.S. Class / Subclass(es): 257/750-766	10/14/2006
Other Documentation:	
Electronic Database(s): EAST (USPAT, EPO, JPO)	10/14/2006



Marcos D. Pizarro-Crespo  
Primary Examiner  
Art Unit 2814  
571-272-1716  
[marcos.pizarro@uspto.gov](mailto:marcos.pizarro@uspto.gov)

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